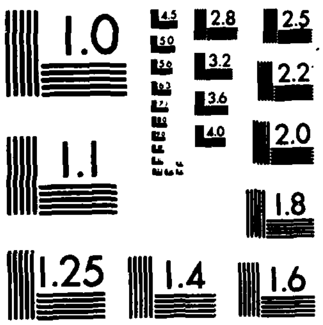
AD-A145 933 AREA EQUIVALENT METHOD ON LOTUS 1-2-3TM(U) FEDERAL AVIATION ADMINISTRATION WASHINGTON DC OFFICE OF ENVIRONMENT AND ENERGY D G WARREN JUL 84 FAA-EE-84-12 1/1

UNCLASSIFIED F/G 20/1 NL

END

FILMED

DTIC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

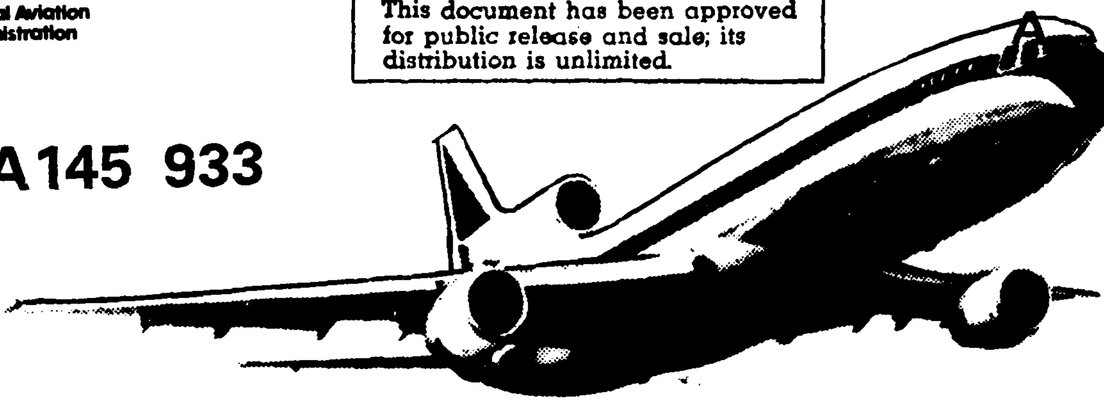
AREA EQUIVALENT METHOD on LOTUS 1-2-3™

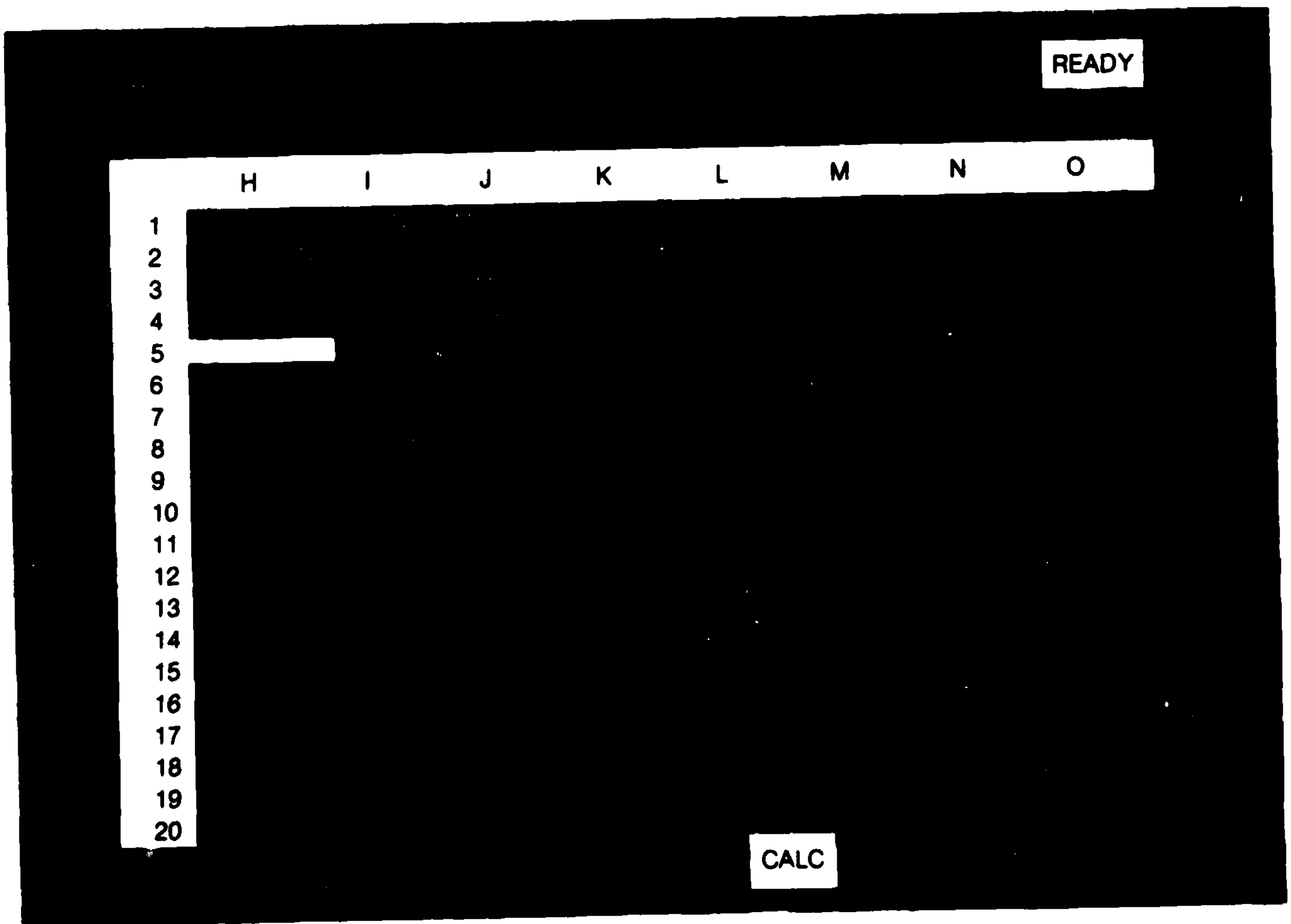
By: Donna G. Warren

July 1984
Report No. EE-84-12

7

U.S. Department of Transportation
Federal Aviation Administration





NOTICE

The United States Government does not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of the report.

Technical Report Documentation Page

1. Report No. FAA-EE-84-12	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Area Equivalent Method on LOTUS 1-2-3		5. Report Date July 1984
		6. Performing Organization Code DOT/FAA
7. Author(s) Donna G. Warren		8. Performing Organization Report No. FAA-EE-84-12
9. Performing Organization Name and Address Federal Aviation Administration Office of Environment and Energy, AEE-120 800 Independence Ave., SW Washington, DC 20591		10. Work Unit No. (TRAIS)
		11. Contract or Grant No.
12. Sponsoring Agency Name and Address		13. Type of Report and Period Covered User's Guide
		14. Sponsoring Agency Code FAA/AEE
15. Supplementary Notes		

16. Abstract

This document contains instructions to execute ~~the Area~~ Equivalent Method (AEM). The AEM requires the LOTUS 1-2-3 software package and an IBM personal computer or a calculator.

The Area equivalent Method is a mathematical process to calculate Day Night Average Sound Level (DNL) contour area. The AEM is easy to use and is intended as a screening procedure to determine the need for an airport Environmental Impact Statement (EIS). This document is the second in a series of reports on the AEM. The first report was titled "Area Equivalent Method on VISICALC®" (Report No. FAA-EE-84-8).

17. Key Words airport noise, computer model, Environmental Impact Statement, Day Night Average Sound Level		18. Distribution Statement A-X(AS)-2	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages	22. Price

ACKNOWLEDGEMENT

The Area Equivalent Method (AEM) was originally developed for the Environmental and Energy Programs Division, Office of Economic Analysis of the Civil Aeronautics Board (CAB). CAB wanted a quick way to determine airport Noise Exposure Forecast (NEF) contour area. The firm of J. Watson Noah Inc. created the original versions of AEM for computer, programmable calculator and pencil and paper (Reference 1). The AEM described within this report draws upon the techniques developed by J. Watson Noah Inc. with updated parameters to calculate Day Night Average Sound Level (DNL) contours.

TABLE OF CONTENTS

		PAGE
1.0	INTRODUCTION................................	1-1
2.0	DESCRIPTION.................................	2-1
3.0	DEVELOPMENT.................................	3-1
4.0	LOTUS 1-2-3 METHOD..........................	4-1
4.1	Instructions........................	4-1
5.0	CALCULATOR METHOD...........................	5-1
5.1	Instructions........................	5-1
APPENDIX A:	AVAILABILITY OF AEM ON LOTUS 1-2-3...	A-1
APPENDIX B:	AEM ON LOTUS 1-2-3 LISTING...........	B-1
APPENDIX C:	REFERENCES...........................	C-1

LIST OF FIGURES

		PAGE
3-1	EXAMPLE OF AEM LINEAR REGRESSION EQUATIONS.............	3-2
4-1	DNLAEM, THE AEM LOTUS 1-2-3 TEMPLATE...................	4-2
4-2	DNLAEM FILLIN FORMAT...................................	4-3
4-3	EXAMPLE OF AEM 65 LDN OUTPUT FROM LOTUS 1-2-3.......	4-4
4-4	EXAMPLE OF AEM 75 LDN OUTPUT FROM LOTUS 1-2-3.......	4-5
5-1	AEM CALCULATOR METHOD WORKSHEET........................	5-3

LIST OF TABLES

		PAGE
3-1	AEM PARAMETERS AND CORRELATION COEFFICIENTS.....	3-3
B-1	LOCATIONS OF A AND B PARAMETERS ON AEM TEMPLATE................................	B-4
B-2	LOCATIONS OF AIRCRAFT NAMES AND IDENTITIES ON AEM TEMPLATE...........................	B-5

1.0 INTRODUCTION

The Area Equivalent Method (AEM) is a mathematical procedure that provides the noise contour area of a specific airport given the types of aircraft and the number of operations for each aircraft. The noise contour area is a measure of the size of the land mass enclosed within a level of noise as produced by a given set of aircraft operations.

The noise contour metric is the Day Night Average Sound Level (DNL) which provides a single quantitative rating of a noise level over a 24-hour period. This rating involves a 10 decibel penalty to aircraft operations during nighttime (between 10pm and 7am) to account for the increased annoyance in the community. (To 1473A)

The AEM produces contour areas (in square miles) for levels of 65 and 75 L_{dn}. The AEM is used to develop insights as to the noise impact of an airport on its surrounding communities, as well as the potential increase or decrease of noise resulting from a change in aircraft operations. The AEM is a useful screening tool in airport planning and development.

The following text will provide a more detailed explanation of the AEM as well as instructions for use of the AEM on the IBM® Personal Computer, IBM/XT™, or COMPAQ™ using the LOTUS 1-2-3™ software program. Instructions on the AEM calculator method are also included.

2.0 DESCRIPTION

According to FAA Order 1050.1D, "Policies and Procedures for Considering Environmental Impacts," an assessment must be made to determine the noise impact of a proposed airport action. This assessment compares the present noise impact on the environment with that of the proposed change. If the noise impact is significant then the FAA requires an Environmental Impact Statement (EIS). If the increase of noise impact on the community is not significant then the FAA prepares a Finding of No Significant Impact (FONSI), which briefly outlines the specifications of the change in airport operations for that particular airport.

An Environmental Impact Statement is a long and involved process which requires use of an airport noise computer model such as the Integrated Noise Model (INM). The INM is a complex and detailed procedure which determines the DNL noise contour area for a specific mix of aircraft, and plots the contour lines relative to runway configuration. The INM is a useful procedure for airport planners, airport operators and local governments in assessing the noise impact to the community around an airport. The INM offers the capability to analyze several operational controls beyond simply changing aircraft mix. The INM is the most appropriate tool for EIS, Airport Noise Control and Land Use Compatability (ANCLUC), Part 150 and other federally funded airport environmental studies.

The Civil Aeronautics Board (CAB) developed the Noise Screening Methodology to decide whether the noise impact due to a change is significant. CAB promulgated this noise screening procedure in 14 CFR 312, Appendix I. It is commonly called the "CAB Procedure." CAB established a decision criterion of 17% increase in cumulative noise contour area. If the percentage difference due to the change is less than 17%, no further study is necessary. A 17% increase in cumulative noise contour area translates into a one decibel increase in the airport noise. The Area Equivalent Method (AEM) is an outgrowth of the CAB Procedure. In Advisory Circular 150/5020-3 "Noise Impact Initial Screening Procedure," the FAA applies the same decision criterion to AEM as the CAB did with the Noise Screening Methodology.

The AEM is a screening procedure used to simplify the assessment step in determining the need for an EIS. The purpose of the AEM is to show change in airport DNL noise contour area relative to a change in aircraft mix and number of operations. The AEM determines the DNL noise contour area in square miles for a mix and number of aircraft types. The basis of AEM is the equation which determines the DNL noise contour area as a function of the number of daily operations. The AEM applies parameters derived from INM output to determine a contour area for each aircraft. The AEM then develops a single equation, representing the specific mix and number of aircraft to produce the contour area for an airport. The contour area produced by the AEM approximates the contour area produced by the INM for a particular airport case.

3.0 DEVELOPMENT

The AEM determines the Day Night Average Sound Level (DNL) noise contour area (in square miles) for a specific case of aircraft operations, given the mix of aircraft types and the number of landing-takeoff cycles (LTOs) per aircraft. In order to create the AEM, aircraft specific parameters relating DNL noise contour area to LTOs were derived from INM output for 65 and 75 L_{dn}. These parameters, represented by the variables a and b, are constants which produce the 65 or 75 L_{dn} contour area due to a specific number of operations of an aircraft from the following equation:

$$A = aN^b$$

The constant a is the noise contour area in square miles of a single LTO for an aircraft. The constant b is a scaling parameter which determines the change in contour area relative to a change in the number of effective LTOs for an aircraft. The noise contour area, A, is the result of applying the parameters a and b to N, the number of effective LTOs. The number of effective LTOs is the sum of the daytime LTOs and the nighttime LTOs of an aircraft. The nighttime LTOs are weighted by a multiple of 10 due to the added amount of annoyance to the community during the nighttime hours between 10pm and 7am.

The Integrated Noise Model (INM) Version 3.8 was used to produce aircraft noise contour areas for specific numbers of LTOs. INM was run for each of the 66 aircraft in the INM Version 3.8 data base. The parameters a and b are determined from the linear regression equation:

$$\log A = \log a + b\log N$$

Figure 3-1 illustrates the linear regression lines derived from this logorithmic equation for each L_{dn}. The INM produced the contour areas as shown by the symbols □ and △. The graph is based on a log - log relationship between the contour area in square miles and the number of LTOs of an aircraft at different values of L_{dn}. Below each regression line on the graph is the equation of that line and a value for the correlation coefficient. The equation is the linear transformation of the logorithmic equation with the parameters a and b and N:

$$A = aN^b$$

The correlation coefficient, r, indicates how well the regression line represents the relationship of contour area to a, b and N. An r value of 1.000 indicates a perfect correlation between the equation and the calculated contour areas for that L_{dn}. The parameters and correlation coefficients for all 66 aircraft in the INM Data Base #8 are given in Table 3.1.

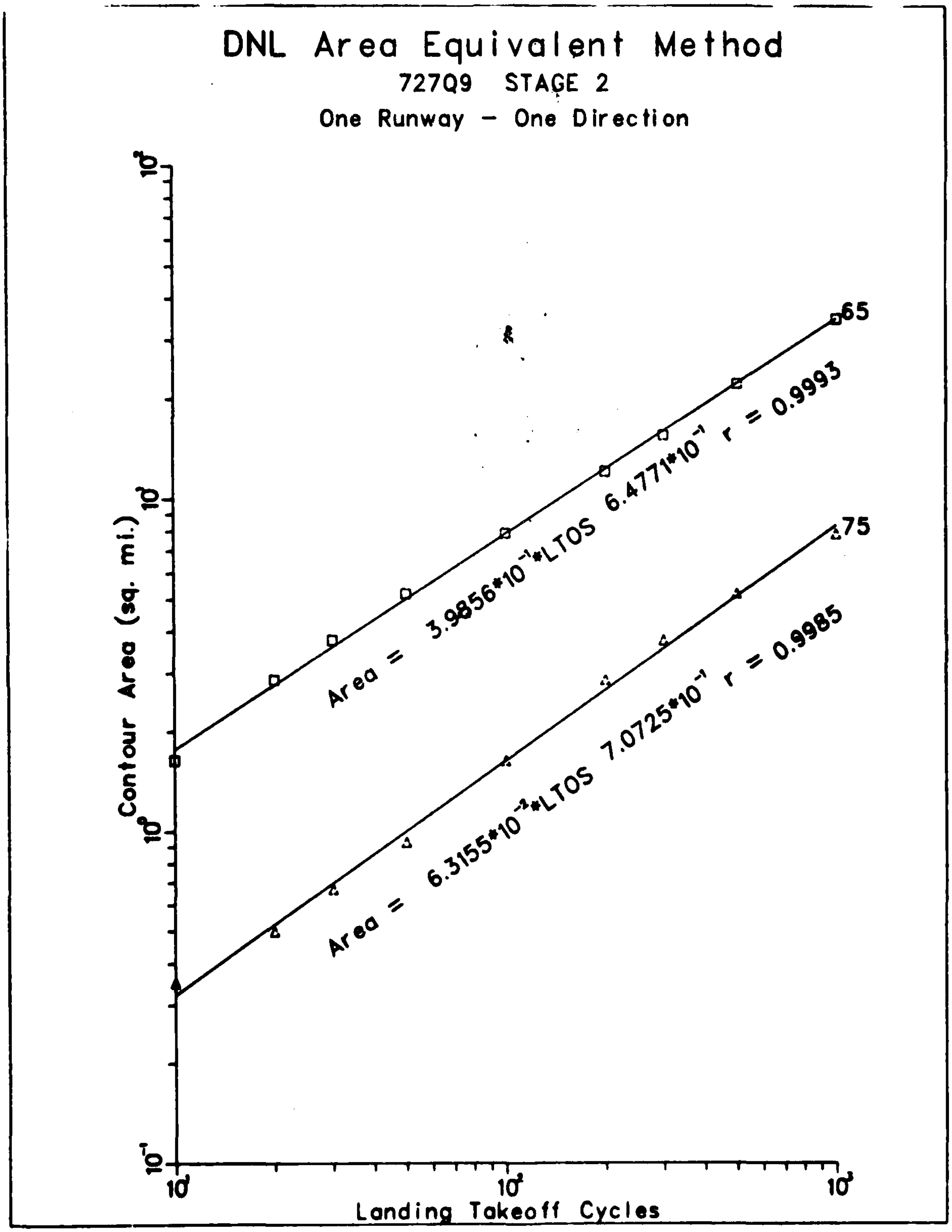


FIGURE 3-1. EXAMPLE OF AEM LINEAR REGRESSION EQUATIONS

TABLE 3-1

AEM PARAMETERS AND CORRELATION COEFFICIENTS

(Part 1 of 2)

AIRCRAFT TYPE	65 LDN a	65 LDN b	65 LDN r	75 LDN a	75 LDN b	75 LDN r
747100	.22594	.70658	.9999	.058717	.6568	.9982
747200	.094848	.71062	.9993	.056022	.52171	.9811
74710Q	.085753	.70686	.9994	.039767	.56111	.9922
747SP	.072382	.70726	.9987	.031276	.57653	.9889
DC820	.54677	.61749	.9995	.094781	.67403	.9994
707	.43092	.63363	.9997	.081632	.6692	.9999
720	.30018	.65145	.9997	.062408	.66438	.9997
707320	.46628	.63776	.9996	.086793	.67387	.9993
707120	.39068	.63666	.9994	.075951	.66588	.9976
720B	.33421	.64428	.9994	.057873	.68983	.9993
DC850	.45335	.6216	.9994	.085881	.66095	.9988
DC860	.50433	.63693	.9997	.093926	.67211	.9992
DC8CFM	.095168	.56752	.9995	.058978	.42531	.9901
707CFM	.090267	.56054	.9976	.075816	.36805	.9844
707QN	.39478	.61722	.9995	.070882	.66658	.9988
DC8QN	.46346	.60835	.9991	.074511	.68043	.9983
CONCRD	3.1758	.80275	.9987	.21072	.96202	.984
DC1010	.055833	.74586	.9981	.057591	.44377	.969
DC1030	.072532	.7207	.9992	.055537	.48144	.9765
DC1040	.069732	.72171	.9991	.055983	.47362	.9736
L1011	.061686	.74073	.9984	.059958	.45116	.9729
L10115	.070318	.73216	.9987	.061885	.46334	.9727
727200	.37045	.66575	.9994	.063094	.70508	.9984
727100	.31686	.66503	.999	.050802	.71719	.9988
727D15	.60539	.59021	.9996	.102036	.6865	.9976
72709	.39856	.64771	.9993	.063155	.70725	.9985
72707	.25431	.67698	.9987	.041575	.72221	.9987
727Q15	.63749	.59125	.9996	.088996	.69357	.9974
727D17	.77352	.58304	.9992	.13103	.65354	.9965
A300	.056243	.70843	.9973	.065947	.40001	.9676
767	.045582	.73509	.9994	.029423	.51749	.9843
A310	.049037	.70737	.9975	.033022	.4913	.9897
BAC111	.15006	.6387	.9998	.045305	.60061	.9996

TABLE 3-1

AEM PARAMETERS AND CORRELATION COEFFICIENTS
(Part 2 of 2)

AIRCRAFT	65 LDN			75 LDN		
TYPE	a	b	r	a	b	r
F28	.11424	.67717	.9979	.061902	.51202	.9969
DC930	.255	.64224	.9992	.047022	.67870	.9992
DC910	.15256	.68445	.9994	.028217	.70457	.9974
737	.20892	.67236	.9977	.032167	.72995	.9991
DC909	.19709	.65771	.9971	.034592	.70398	.9957
DC907	.12141	.69248	.9992	.023937	.69715	.9941
737QN	.17448	.68081	.9973	.02582	.7414	.9974
DC950	.54058	.58632	.9992	.084585	.6713	.9977
737D17	.47652	.58646	.999	.058649	.7154	.9983
DC980	.057292	.7005	.9989	.029371	.53347	.985
757RB	.035748	.78426	.9998	.028126	.51577	.9737
757JT	.035748	.78426	.9998	.028126	.51577	.9737
COMJET	.28504	.61027	.9993	.058735	.64206	.9995
GALTF	.044167	.62141	.9993	.030673	.4399	.9814
GALTJ	.38843	.60457	.9996	.061997	.68055	.999
GAMTF	.052119	.63153	.9971	.037255	.43601	.9889
GALQTF	.022013	.52699	.9789	.015311	.3752	.9882
L188	.016869	.78133	.9863	.029594	.37025	.9639
L100	.033394	.79478	.9983	.026474	.51704	.9815
DHC7	.011101	.68707	.9794	.0073122	.47978	.9967
CV580	.020242	.632	.9712	.025308	.33308	.9961
HTETP	.026254	.69683	.9935	.030705	.39219	.9764
MTETP	.023894	.51311	.9644	.020488	.33031	.9881
DHC6	.015311	.4805	.9796	.0042779	.51577	.9779
4EP	.058605	.81526	.9993	.033666	.58784	.9876
TEP	.042943	.75885	.9969	.034507	.49549	.9898
COMTEP	.01671	.49302	.9749	.004013	.54427	.9773
COMSEP	.0096306	.54076	.9782	.0026634	.54335	.9829
KC135	2.7093	.63015	.998	.45159	.69334	.9995
C130	.033394	.79478	.9983	.026474	.51704	.9815
F4	1.0301	.66118	.9999	.23697	.65296	.9994
A7D	.47499	.6464	.9996	.11567	.63347	.9996
CL600	.049046	.5045	.9848	.039268	.33787	.9976

4.0 LOTUS 1-2-3 METHOD

The AEM doesn't require any programming experience. It does require LOTUS 1-2-3™ and an IBM® Personal Computer, an IBM/XT™, or the COMPAQ™ portable computer. LOTUS 1-2-3 is an electronic worksheet which is combined with graphics and data base management. In LOTUS 1-2-3 parlance, AEM is a template called DNLAEM (Figure 4-1) which is stored on a 5-1/4 inch diskette. Appendix A provides instructions on how to obtain a copy of DNLAEM. When retrieved from the diskette the DNLAEM template becomes a worksheet to which you add aircraft identities and the associated landings and takeoffs (LTOs) in the appropriate columns (see Figure 4-2).

DNLAEM contains all the equations necessary to calculate an airport contour area from the list of aircraft types and LTOs. DNLAEM includes the a and b parameters for each of the 66 aircraft shown in Table 3-1. The following instructions should lead you to produce output reports similar to those examples in Figures 4-3 and 4-4. The keystrokes are given in **boldface** type. **ENTER** indicates the key labeled ↵ . An item enclosed in **[ ]** indicates one of the special function keys located on the left of the IBM keyboard.

4.1 INSTRUCTIONS

Once you have LOTUS 1-2-3 booted with a blank template on the screen follow these procedures to run the AEM.

Instruction	Comment
STEP 1. Insert AEM Disk into Drive A.	
STEP 2. **/FD**	**/** shifts you into command menu. **F** selects File. **D** indicates desire to change drive and directory.
STEP 3. **A:** and **ENTER**	Changes drive and directory.
STEP 4. **/FR**	**/** shifts you into the command menu. **F** selects File. **R** indicates the desire to retrieve a template.
STEP 5. Hit **→** until 'DNLAEM' is highlighted.	
STEP 6. Hit **ENTER** .	The AEM template is being loaded.

DNLAEM
Day Night Average Sound Level
Area Equivalent Method

________(((Title (Hit * to start)
________(((Level (1=65 or 2=75 Ldn)

NA Ldn

Aircraft ID	LTO Cycles Day	LTO Cycles Night	Weighted	Constants a	Constants b	Aircraft Area	Energy	Wgtings	To Verify Area LTOs	To Verify Area Eff LTOs
!______!	!______!	!______!	0	NA	NA	0	0	0	0	0
!______!	!______!	!______!	0	NA	NA	0	0	0	0	0
!______!	!______!	!______!	0	NA	NA	0	0	0	0	0
!______!	!______!	!______!	0	NA	NA	0	0	0	0	0
!______!	!______!	!______!	0	NA	NA	0	0	0	0	0
!______!	!______!	!______!	0	NA	NA	0	0	0	0	0
!______!	!______!	!______!	0	NA	NA	0	0	0	0	0
!______!	!______!	!______!	0	NA	NA	0	0	0	0	0
!______!	!______!	!______!	0	NA	NA	0	0	0	0	0
!______!	!______!	!______!	0	NA	NA	0	0	0	0	0
!______!	!______!	!______!	0	NA	NA	0	0	0	0	0
!______!	!______!	!______!	0	NA	NA	0	0	0	0	0
!______!	!______!	!______!	0	NA	NA	0	0	0	0	0
!______!	!______!	!______!	0	NA	NA	0	0	0	0	0
!______!	!______!	!______!	0	NA	NA	0	0	0	0	0
!______!	!______!	!______!	0	NA	NA	0	0	0	0	0
!______!	!______!	!______!	0	NA	NA	0	0	0	0	0
!______!	!______!	!______!	0	NA	NA	0	0	0	0	0
!______!	!______!	!______!	0	NA	NA	0	0	0	0	0
!______!	!______!	!______!	0	NA	NA	0	0	0	0	0
						0	0	0		0
Totals:	0	0	0			0 (Ref Area		Validity Test (1=TRUE,0=FALSE)		0

Contour Area = NA sq. mi.

FIGURE 4-1. DNLAEM, THE AEM LOTUS 1-2-3 TEMPLATE

DNLAEM
Day Night Average Sound Level
Area Equivalent Method

__________<<<Title (Hit " to start)
__________<<<Level (1=65 or 2=75 Ldn)

Aircraft ID	LTO Cycles Day	Night	Aircraft Type	Aircraft ID	Aircraft Type	Aircraft ID
			747100	1	F28	34
			74/200	2	DC930	35
			747100	3	DC910	36
			747SP	4	737	37
			DC820	5	DC9Q9	38
			707	6	DC9Q7	39
			720	7	737QN	40
			707320	8	DC950	41
			707120	9	737D17	42
			720B	10	DC980	43
			DC850	11	757RB	44
			DC860	12	757JT	45
			DC8CFM	13	COMJET	46
			707CFM	14	GALTF	47
			707QN	15	GALTJ	48
			DC8QN	16	GAMTF	49
			CONCRD	17	GALQTF	50
			DC1010	18	L188	51
			DC1030	19	L100	52
			DC1040	20	DCH7	53
			L1011	21	CV580	54
Totals:	0	0	L1011S	22	HTETP	55
			727200	23	MTETP	56
			727100	24	DCH6	57
			727D15	25	4EP	58
			727Q9	26	TEP	59
			727Q7	27	COMTEP	60
			727Q15	28	COMSEP	61
			727D17	29	KD135	62
			A300	30	C130	63
			767	31	F4	64
			A310	32	A7D	65
			BAC111	33	CL600	66

FIGURE 4-2. DNLAEM FILLIN FORMAT

DNLAEM
Day Night Average Sound Level
Area Equivalent Method

LONG BCH (((Title (Hit " to start)
1 (((Level (1=65 or 2=75 Ldn)

65 Ldn

Aircraft	LTO Cycles			Constants		Aircraft			To Verify Area	
ID	Day	Night	Weighted	a	b	Area	Energy	Wgtings	LTOs	Eff LTOs
26	3	!_______!	3	0.39856	0.64771	0.011951	0.575040	0.887804	9.076822	0.330512
43	14	!_______!	14	0.037292	0.7005	0.363078	0.190634	0.272140	122.5498	0.114239
46	10	!_______!	10	0.28504	0.61027	1.161918	1	1.638618	17.99973	0.555563
!_______!	!_______!	!_______!	0	NA	NA	0	0	0	0	0
!_______!	!_______!	!_______!	0	NA	NA	0	0	0	0	0
!_______!	!_______!	!_______!	0	NA	NA	0	0	0	0	0
!_______!	!_______!	!_______!	0	NA	NA	0	0	0	0	0
!_______!	!_______!	!_______!	0	NA	NA	0	0	0	0	0
!_______!	!_______!	!_______!	0	NA	NA	0	0	0	0	0
!_______!	!_______!	!_______!	0	NA	NA	0	0	0	0	0
!_______!	!_______!	!_______!	0	NA	NA	0	0	0	0	0
!_______!	!_______!	!_______!	0	NA	NA	0	0	0	0	0
!_______!	!_______!	!_______!	0	NA	NA	0	0	0	0	0
!_______!	!_______!	!_______!	0	NA	NA	0	0	0	0	0
!_______!	!_______!	!_______!	0	NA	NA	0	0	0	0	0
!_______!	!_______!	!_______!	0	NA	NA	0	0	0	0	0
!_______!	!_______!	!_______!	0	NA	NA	0	0	0	0	0
!_______!	!_______!	!_______!	0	NA	NA	0	0	0	0	0
!_______!	!_______!	!_______!	0	NA	NA	0	0	0	0	0
!_______!	!_______!	!_______!	0	NA	NA	0	0	0	0	0
						1.161918	1.765674	2.798564		1.000315
Totals:	27	0	27			1.161918 (Ref Area		Validity Test		1
								(1=TRUE,0=FALSE)		

Contour Area = 1.66 sq. mi.

FIGURE 4-3. EXAMPLE OF AEM 65 L_{dn} OUTPUT FROM LOTUS 1-2-3

DNLAEM
Day Night Average Sound Level
Area Equivalent Method

LONG BCH (((Title (Hit " to start)
2 (((Level (1=65 or 2=75 Ldn)

75 Ldn

Aircraft	LTO Cycles			Constants		Aircraft			To Verify Area	
ID	Day	Night	Weighted	a	b	Area	Energy	Wgtings	LTOs	Eff LTOs
26	3		3	0.063155	0.70725	0.137357	0.411006	0.581133	11.46647	0.261632
43	14		14	0.029371	0.53347	0.120044	0.238992	0.447996	106.6106	0.131318
46	10		10	0.058735	0.64206	0.257606	1	1.557406	16.44652	0.608031
			0	NA	NA	0	0	0	0	0
			0	NA	NA	0	0	0	0	0
			0	NA	NA	0	0	0	0	0
			0	NA	NA	0	0	0	0	0
			0	NA	NA	0	0	0	0	0
			0	NA	NA	0	0	0	0	0
			0	NA	NA	0	0	0	0	0
			0	NA	NA	0	0	0	0	0
			0	NA	NA	0	0	0	0	0
			0	NA	NA	0	0	0	0	0
			0	NA	NA	0	0	0	0	0
			0	NA	NA	0	0	0	0	0
			0	NA	NA	0	0	0	0	0
			0	NA	NA	0	0	0	0	0
			0	NA	NA	0	0	0	0	0
			0	NA	NA	0	0	0	0	0
			0	NA	NA	0	0	0	0	0
						0.257606	1.649999	2.586616		1.000982
Totals:	27	0	27			0.257606 (Ref Area		Validity Test (1=TRUE,0=FALSE)		1

Contour Area = 0.35 sq. mi.

FIGURE 4-4. EXAMPLE OF AEM 75 L_{dn} OUTPUT FROM LOTUS 1-2-3

	Instruction	Comment
STEP 7.	Wait for the cursor to appear in coordinate H5. If you are not in H5 type **[F5]H5** and **ENTER** .	**[F5]** invokes the GOTO command and H5 indicates the destination coordinate.
STEP 8.	Hit " (quote mark), enter title (up to 9 characters) and hit **ENTER** .	The " causes LOTUS 1-2-3 to treat the entry as a label.
STEP 9.	Hit ↓ .	The cursor moves to H6.
STEP 10.	Enter **1** or **2** and **ENTER** .	You are choosing between calculating 65 L_{dn} (1) or 75 L_{dn} (2) contour area.
STEP 11.	Type **[F5]H11** and **ENTER** .	The cursor moves to the first coordinate under the column labeled 'Aircraft ID'.
STEP 12.	For each aircraft type enter corresponding ID and hit ↓ .	The cursor moves down the column as you enter each aircraft. Up to 20 allowed.
STEP 13.	Type **[F5]I11** and **ENTER** .	The cursor moves to the first coordinate under the column labeled 'DAY'.
STEP 14.	For each aircraft type enter the corresponding LTOs during daytime and hit ↓ .	Daytime includes the hours 7am to 10pm. The cursor moves down the column after each entry.
STEP 15.	Type **[F5]J11** and **ENTER** .	The cursor moves to the first coordinate under the column labeled 'NIGHT'.
STEP 16.	For each aircraft type enter the LTOs which occur at night and hit ↓ .	Night includes the hours 10pm to 7am. The cursor moves down the column after each entry.
STEP 17.	Type **[F9]** .	The cursor disappears and the computations have begun. Return of cursor signals end of calculations.

Instruction		Comment
STEP 18.	Type **[F5]K31** and **ENTER** .	
STEP 19.	If coordinate P35 contains 'NA' then type **[F5]H6** and **ENTER** . Go back to STEP 7 and check your entries.	Something is wrong with your input.
STEP 20.	If coordinate R32 contains '1' then skip to STEP 29.	Your results are correct. You may now print them out.
STEP 21.	Write down value in R31.	Validity test is FALSE.
STEP 22.	Type **[F5]N32** and **ENTER** .	N32 contains reference area.
STEP 23.	Enter a new reference contour area.	If value in R31 is greater than 1.02 then enter a number less than shown. Otherwise, enter a number greater than shown.
STEP 24.	Hit **ENTER** then **[F9]**	Recalculation starts. Await return of cursor.
STEP 25.	Type **[F5]K31** and **ENTER** .	
STEP 26.	If R32 contains '0' then repeat steps 21 through 25 until R32 contains '1'.	
STEP 27.	Type **[F5]N32** and **ENTER** .	Validity test is now TRUE.
STEP 28.	Type **+N31** and **ENTER**	The coordinate N32 is now returned to its original value.
STEP 29.	Write down contour area.	If you don't have a printer, you are done.
STEP 30.	Type **[F5]H1** and **ENTER** .	
STEP 31.	Make sure printer is turned on and ready.	
STEP 32.	Type **/PPR H1.R35** and **ENTER** .	**/** shifts into command menu. **P** is PRINT command. **P** indicates that output goes to PRINTER. **R** indicates you want to enter the RANGE of cells to be printed. **H1.R35** are cells to be printed. Cursor returns to PRINTER menu. If you are printing on 14"x11" paper, skip to step 35.

Instruction	Comment
STEP 33. Type **OS** and	**O** shifts into OPTIONS menu. **S** indicates you would like to enter special printer SETUP commands.
\030, or	For 12 CPI.
\031, or	For 16.8 CPI.
\029 and **ENTER** .	To return to default of 10 CPI. These commands work only with certain kinds to printers. Cursor returns to OPTIONS menu.
STEP 34. Type **Q** .	**Q** is QUIT OPTIONS menu and return to PRINTER menu.
STEP 35. Type **G** .	**G** is GO command. Worksheet is being printed. Cursor returns to PRINTER menu.
STEP 36. Type **Q** .	**Q** allows you to leave the PRINTER menu.

The real utility of LOTUS 1-2-3 comes from the fact that the worksheet is still available for you to change any of your entries and rerun. For example, let's say that you have just produced the 65 L_{dn} contour area and you want to calculate the area within 75 L_{dn}. Simply go to coordinate H6 and enter a 2 and ENTER. Skip to STEP 17 and proceed. You can do the same thing with aircraft types or LTOs. You can even save just the worksheet portion and then reload it onto a blank AEM template later. To save, you would use /FX which creates a file (you supply a filename) that stores all data currently located in the indicated cell range. To reload the file you would use /FC which would overlay the stored worksheet portion over the current AEM template at the specified location. You could then make necessary changes to that data and proceed again from STEP 17.

5.0 CALCULATOR METHOD

In the event that an IBM computer and LOTUS 1-2-3 software are not available, your calculator and the worksheet in Figure 5-1 make good substitutes. With the following instructions, you perform the same tasks as accomplished by the AEM on LOTUS 1-2-3.

5.1 INSTRUCTIONS

STEP 1. Enter aircraft types in column 1.

STEP 2. Enter the daytime and nighttime LTOs for each aircraft type in columns 2 and 3, respectively.

STEP 3. Compute the effective LTOs of each aircraft in column 4 by multiplying the nighttime LTOs from column 3 by 10 and adding the daytime LTOs from column 2.

STEP 4. Enter in columns 5 and 6 the appropriate aircraft a and b parameters for either 65 or 75 L_{dn} from Table 3-1.

STEP 5. Compute the area of each aircraft by applying the equation in the development section $A=aN^b$, where a is in column 5, b is in column 6, and N is the number of effective LTOs in column 4. Enter the area A, for each aircraft in column 7.

STEP 6. Select the largest area in column 7 and refer to this as the "reference area," A_R.

STEP 7. Calculate the energy contribution E for each aircraft. This is done by dividing the area of each aircraft by the reference area and raising the quotient to the power of the reciprocal of the b parameter (1/b). Enter the result in column 8.

STEP 8. Sum column 8 and enter the result in the box labeled $\overline{E}$.

STEP 9. Calculate the weighting factor W for each aircraft with the equation $W=E/b$. Divide the energy contribution E of each aircraft by the b parameter and enter the quotient in column 9.

STEP 10. Sum column 9 and enter the result in the box labeled $\overline{W}$.

STEP 11. Calculate the scaling parameter $\overline{b}$ for the aircraft mix by dividing $\overline{E}$ by $\overline{W}$. Enter the quotient in the box labeled $\overline{b}$.

STEP12. Calculate the contour area of the aircraft mix by applying the energy contribution $\overline{E}$, the scaling parameter $\overline{b}$, and the reference area A_R to the equation $\overline{A}=A_R(\overline{E}^{\overline{b}})$. The result $\overline{A}$ is the DNL noise contour area of the specific aircraft mix.

STEP 13. Determine the number of LTOs that each aircraft must fly in order to have a noise contour area equal to that of the entire mix. This is done by dividing the DNL noise contour area of the entire mix $\overline{A}$ by the parameter a in column 5 and raising the quotient to the power of the reciprocal of the b parameter in column 6. Enter the result $\overline{N}$ in column 10.

STEP 14. Calculate the ratio of LTOs of each aircraft by dividing the effective LTOs in column 4 by $\overline{N}$ in column 10. Enter the result in column 11.

STEP 15. Sum column 11 and enter the result in the box labeled 'Validity Check'.

STEP 16. If the validity value is between 1.00 and 1.02 then the result is correct. You are done. Record the contour area from the box labeled "A:" into the box labeled "Contour Area:".

STEP 17. If the validity value is not between 1.00 and 1.02, return to STEP 1 and check all your figures.

STEP 18. If the validity check produces the same value, change the reference area according to the following:
(a) If the validity value is greater than 1.02, enter a reference area less than already present.
(b) If the validity value is less than 1.00, enter a reference area greater than already present.

STEP 19. Repeat the steps starting at STEP 7.

Day Night Average Sound Level
Area Equivalent Method

Calculator Method

1	2	3	4	5	6	7	8	9	10	11
Aircraft Type	Daytime LTOs	Nighttime LTOs	Effective LTOs	Constants		Aircraft Area	Energy	Weighting Factor	Verification	
				a	b	$A=aN^{b}$	$E=\left(\frac{A}{A_R}\right)^{\frac{1}{b}}$	$W=E/b$	# of LTOs $\bar{N}=\left(\frac{\bar{A}}{a}\right)^{\frac{1}{\bar{b}}}$	$\frac{\text{Eff. LTOs} - \bar{N}}{\text{Eff. LTOs}}$

Reference A_R	Energy $\bar{E}$	Weighting $\bar{W}$	Validity Check
$\bar{b}$:	$\bar{A}$:	Contour Area:	

FIGURE 5-1. AEM CALCULATOR METHOD WORKSHEET

APPENDIX A

AVAILABILITY OF AEM ON LOTUS 1-2-3

The AEM is available on a double-sided, double-density 5-1/4 inch diskette. The information on the diskette is compatible with LOTUS 1-2-3™ for IBM® personal computer, IBM/XT™, and COMPAQ™ portable computer. The cost to you is $10 for materials and services. To order AEM on LOTUS 1-2-3, fill out request form (p. A-2) and send with check or money order payable to the "United States Treasury" to:

Federal Aviation Administration
AEE-120
800 Independence Ave., S.W.
Washington, DC 20591
Attention: Donna G. Warren

Appendix B contains a listing of the AEM template for LOTUS 1-2-3.

AEM ON LOTUS 1-2-3 REQUEST

I request a 5-1/4 inch diskette of the AEM.

NAME: ______________________________

TITLE: ______________________________

COMPANY: ______________________________

STREET ADDRESS: ______________________________

CITY, STATE ZIP: ______________________________

TELEPHONE NO.: ______________________________

APPENDIX B

AEM TEMPLATE LISTING

This appendix contains the keystrokes to create the DNLAEM template on LOTUS 1-2-3. Please refer to the LOTUS 1-2-3 user manual for an explanation of the commands. Entry at a particular coordinate (or cell) is shown as the coordinate identification followed by a colon and then the appropriate keystrokes. Keystrokes which are shown without a coordinate identification always refer to the previously specified coordinate, usually on the line above. Table B-1 contains the locations (row and column) of the specific aircraft a and b parameters on the AEM template. Table B-2 provides the locations of the aircraft names and identifications.

```
A1 : '/wgfg/wgrm{goto}o1~{goto}h1~{down}{down}{down}{down}
     /RNC\0
     A1
     /WGFG/WGRM
A8 : ($H$6-1)*2+1
A11: +H11
     /C
     A12.A30
B10: "a
B11: @IF(A11=0,@NA,@VLOOKUP(A11,$B$47.$F$112,$A$8))
     /C
     B12.B30
C10: "b
C11: @IF(A11=0,@NA,@VLOOKUP(A11,$B$47.$F$112,($A$8+1)))
     /C
     C12.C30
H2 : "Day Night
H3 : "   Area E
H5 : '_________ (9 underline strokes)
H6 : '_________
H9 : 'Aircraft
H10: ^ID
H11: "!_______! (7 underline strokes between two exclamation points)
     /C
     H12.H30
     /C
     H11.H30
     I11.J30
H32: "Totals:
I1 : "DNLAEM
I2 : "Average
I3 : "quivalent
I5 : "<<<Title
I6 : "<<<Level
I9 : "          L
I10: "Day
I32: @SUM(I11.I30)
     /C
     J32.K32
```

AEM TEMPLATE LISTING (continued)

```
J2  : "Sound Lev
J3  : ' Method
J5  : '(Hit " to
J6  : '(1=65 or
J9  : 'TO Cycles
J10: '  Night
K2  : 'el
K5  : ' start)
K6  : '2=75 Ldn)
K10: ' Weighted
K11: +I11+(J11*10)
     /C
     K12.K30
L9  : '      Cons
L10: ^a
L11: @IF(@ISNA(B11),@NA,B11)
     /C
     L12.L30
M7  : @IF(H6<1#OR#H6>2,@NA,@CHOOSE(H6-1,65,75))
M9  : 'tants
M10: ^b
M11: @IF(@ISNA(C11),@NA,C11)
     /C
     M12.M30
N7  : "Ldn
N9  : "Aircraft
N10: ^Area
N11: @IF(@ISNA(L11),0,+L11*(K11^M11))
     /C
     N12.N30
N31: @MAX(N11..N30)
N32: +N31
N35: "   Contou
O10: "Energy
O11: @IF(($N$32=0#OR#@ISNA(M11)),0,(N11/$N$32)^(1/M11))
     /C
     O12.O30
O31: @SUM(O11.O30)
O32: '(Ref Area
O35: "r Area =
P10: "Wgtings
P11: @IF(@ISNA(M11),0,O11/M11)
     /C
     P12.P30
P31: @SUM(P11.P30)
P32: "     Valid
P33: '     (1=TR
P35: /RFF2P35
     @IF(P31=0,@NA,+(O31^(O31/P31))*N31)
```

AEM TEMPLATE LISTING (continued)

```
Q9 : "  To Veri
Q10: "LTOs
Q11: @IF((@ISNA(L11)#OR#@ISNA(M11)),0,($P$35/L11)^(1/M11))
     /C
     Q12.Q30
Q32: 'ity Test
Q33: 'UE,0=FALS
Q35: " sq. mi.
R9 : 'fy Area
R10: 'Eff LTOs
R11: @IF(Q11=0,0,+K11/Q11)
     /C
     R12.R30
R31: @SUM(R11.R30)
R32: @IF((R31)=1#AND#R31(=1.02),@TRUE,@FALSE)
R33: 'E)
```

TABLE B-1

LOCATIONS OF A AND B PARAMETER ON AEM TEMPLATE

		COLUMN A	B	C	D	E	F
	44 !	AIRCRAFT	AIRCRAFT	65 LDN	65 LDN	75 LDN	75 LDN
	45 !	TYPE	ID	A	B	A	B
	46 !						
	47 !	747100	1	0.22594	0.70658	0.058717	0.6560
	48 !	747200	2	0.094848	0.71062	0.056022	0.52171
	49 !	747100	3	0.085753	0.70686	0.039767	0.56111
	50 !	747SP	4	0.072302	0.70726	0.031276	0.57653
	51 !	DC820	5	0.54677	0.61749	0.094701	0.57653
	52 !	707	6	0.43092	0.63363	0.081632	0.67403
	53 !	720	7	0.30018	0.65145	0.062408	0.6692
	54 !	707320	8	0.46628	0.63776	0.086793	0.66438
	55 !	707120	9	0.39068	0.63666	0.075951	0.67387
	56 !	720B	10	0.33421	0.64428	0.057873	0.68983
	57 !	DC850	11	0.45335	0.6216	0.085801	0.66095
	58 !	DC860	12	0.50433	0.63693	0.093926	0.67211
	59 !	DC8CFM	13	0.095168	0.56752	0.050978	0.42531
	60 !	707CFM	14	0.090267	0.56054	0.075016	0.36805
R	61 !	707QN	15	0.39478	0.61722	0.070882	0.66658
O	62 !	DC8QN	16	0.46346	0.60835	0.074511	0.68043
W	63 !	CONCRD	17	3.1758	0.80275	0.21072	0.96202
	64 !	DC1010	18	0.055033	0.74586	0.057591	0.44377
	65 !	DC1030	19	0.072532	0.7207	0.055537	0.48144
	66 !	DC1040	20	0.069732	0.72171	0.055983	0.47362
	67 !	L1011	21	0.061686	0.74073	0.059958	0.45116
	68 !	L10115	22	0.070318	0.73216	0.061805	0.46334
	69 !	727200	23	0.37045	0.66575	0.063094	0.70508
	70 !	727100	24	0.31686	0.66503	0.050802	0.71719
	71 !	727D15	25	0.60539	0.59125	0.102036	0.6865
	72 !	727Q9	26	0.39856	0.64771	0.063155	0.70725
	73 !	727Q7	27	0.25431	0.67698	0.041575	0.72221
	74 !	727Q15	28	0.63749	0.59125	0.080996	0.69357
	75 !	727D17	29	0.77352	0.50304	0.13183	0.65354
	76 !	A300	30	0.056243	0.70043	0.065947	0.40001
	77 !	767	31	0.045502	0.73509	0.029423	0.51749
	78 !	A310	32	0.049037	0.70737	0.033022	0.4913

		COLUMN A	B	C	D	E	F
	79 !	BAC111	33	0.15806	0.6387	0.045305	0.60061
	80 !	F28	34	0.11424	0.67717	0.061902	0.61202
	81 !	DC930	35	0.255	0.64224	0.047022	0.67078
	82 !	DC910	36	0.15256	0.68445	0.028217	0.70457
	83 !	737	37	0.20892	0.67236	0.032167	0.72995
	84 !	DC9Q9	38	0.19709	0.65771	0.034592	0.70398
	85 !	DC9Q7	39	0 12141	0.69248	0.023937	0.69715
	86 !	737QN	40	0.17448	0.68081	0.02502	0.7414
	87 !	DC950	41	0.54058	0.58632	0.084585	0.6713
	88 !	737D17	42	0.47652	0.58646	0.050649	0.7154
	89 !	DC980	43	0.057292	0.7085	0.029371	0.53347
	90 !	757RB	44	0.035748	0.78426	0.028126	0.51577
	91 !	757JT	45	0.035748	0.78426	0.028126	0.51577
	92 !	COMJET	46	0.28504	0.61027	0.050735	0.64286
	93 !	GALTF	47	0.044167	0.62141	0.030673	0.4399
	94 !	GALTJ	48	0.38043	0.68457	0.061997	0.68055
	95 !	GAMTF	49	0.052119	0.63153	0.037255	0.43601
R	96 !	GALQTF	50	0.022013	0.52699	0.015311	0.3752
O	97 !	L188	51	0.016859	0.70133	0.029594	0.37025
W	98 !	L100	52	0.033394	0.79478	0.026474	0.51704
	99 !	DCH7	53	0.011101	0.68707	0.007312	0.47978
	100 !	CV580	54	0.020242	0.632	0.025308	0.33308
	101 !	MTETP	55	0.026254	0.69683	0.030705	0.39219
	102 !	MTETP	56	0.023094	0.51311	0.020408	0.33031
	103 !	DCH6	57	0.015311	0.4805	0.004277	0.51577
	104 !	4EP	58	0.050605	0.81526	0.033666	0.50704
	105 !	TEP	59	0.042943	0.75085	0.034507	0.49549
	106 !	COMTEP	60	0.01671	0.49302	0.004013	0.54427
	107 !	COMSEP	61	0.009630	0.54076	0.002663	0.54335
	108 !	XD135	62	2.7893	0.63015	0.45159	0.69334
	109 !	C130	63	0.033394	0.79478	0.026474	0.51704
	110 !	F4	64	1.0301	0.66118	0.23697	0.65296
	111 !	A7D	65	0.47499	0.6464	0.11567	0.63347
	112 !	CL600	66	0.049046	0.5045	0.039268	0.33787

TABLE B-2

LOCATIONS OF AIRCRAFT NAMES AND IDENTITIES ON AEM TEMPLATE

			COLUMN			
			S	T	U	V
	9	!	Aircraft	Aircraft	Aircraft	Aircraft
	10	!	Type	ID	Type	ID
	11	!	747100	1	F28	34
	12	!	747200	2	DC930	35
	13	!	747100	3	DC910	36
	14	!	747SP	4	737	37
	15	!	DC820	5	DC9Q9	38
	16	!	707	6	DC9Q7	39
	17	!	720	7	737QN	40
	18	!	707320	8	DC950	41
	19	!	707120	9	737D17	42
	20	!	720B	10	DC980	43
	21	!	DC850	11	757RB	44
	22	!	DC860	12	757JT	45
	23	!	DC8CFM	13	COMJET	46
	24	!	707CFM	14	GALTF	47
R	25	!	707QN	15	GALTJ	48
O	26	!	DC8QN	16	GAMTF	49
W	27	!	CONCRD	17	GALQTF	50
	28	!	DC1010	18	L188	51
	29	!	DC1030	19	L100	52
	30	!	DC1040	20	DCH7	53
	31	!	L1011	21	CV580	54
	32	!	L10115	22	HTETP	55
	33	!	727200	23	MTETP	56
	34	!	727100	24	DCH6	57
	35	!	727D15	25	4EP	58
	36	!	727Q9	26	TEP	59
	37	!	727Q7	27	COMTEP	60
	38	!	727Q15	28	COMSEP	61
	39	!	727D17	29	KD135	62
	40	!	A300	30	C130	63
	41	!	767	31	F4	64
	42	!	A310	32	A7D	65
	43	!	BAC111	33	CL600	66

APPENDIX C

REFERENCES

1. Civil Aeronautics Board, "Area Equivalent Method," February 1982.

2. Flythe, M. C., "INM Integrated Noise Model, Version 3 User's Guide," FAA-EE-81-17, October 1982.

3. Connor, T. L. and Fortescue, D.N., "Area Equivalent Method on VISICALC®, FAA-EE-84-8, February 1984.